PARASITOIDS OF THE COLUMBIA RIVER BASIN

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Preface

The following report was prepared by University scientists through cooperative agreement, project science staff, or contractors as part of the ongoing efforts of the Interior Columbia Basin Ecosystem Management Project, co-managed by the U.S. Forest Service and the Bureau of Land Management. It was prepared for the express purpose of compiling information, reviewing available literature, researching topics related to ecosystems within the Interior Columbia Basin, or exploring relationships among biophysical and economic/social resources.

This report has been reviewed by agency scientists as part of the ongoing ecosystem project. The report may be cited within the primary products produced by the project or it may have served its purposes by furthering our understanding of complex resource issues within the Basin. This report may become the basis for scientific journal articles or technical reports by the USDA Forest Service or USDI Bureau of Land Management. The attached report has not been through all the steps appropriate to final publishing as either a scientific journal article or a technical report.

Parasitoids of the Columbia River Basin

Taxonomy

Insect parasitoids are among the most poorly known groups. Many are taxonomically difficult or simply insufficiently known, e.g. Ichneumonidae and Chalcidoidea, respectively. For general accounts of parasitic insects see, Waage and Greathead 186, Askew 1971 and Clausen 1940. Some additional information can be obtained from biological control texts, e.g. Huffaker & Messenger (1976)(biology and host relationships), DeBach (1973)(development, systematics, culture and nutrition).

Compilation from numerous sources indicates that there are about 96,000 known species of insect parasitoids in the world. The actual number will be much higher. The number of species in the Columbia River Basin is unknown. They occur in six orders:

Neuroptera	200 species
Coleoptera	5,400
Strepsiptera	300
Lepidoptera	300
Diptera	10,000
Hymenoptera	80,000

Because of their numerical and apparent ecological dominance the rest of this report will focus on the Diptera and Hymenoptera. (However, see Table 1 for a more complete listing of taxa.)

Among the Diptera, the family Tachinidae is the most important taxon, including approximately 8000 species in the world and 1200 in America north of Mexico (Wood 1987), the number of species in the Columbia River Basin is unknown. This work also gives the most recent key to genera for the North American fauna. Though older, and thus not up-to-date

nomenclaturally, Cole (1969), is sometimes useful and is easier to use since its scope is limited to the Western North America. Older and therefore less useful due to intervening taxonomic changes is Curran 1965.

Identification below the genus level requires acquisition of specific journal articles. Those published prior to 1987 are cited in Wood (1987). Because the taxonomy of many genera is difficult it will often be necessary to seek determinations from specialists. Additionally, some genera are in need of revision so that no authoritative determination is possible. This exemplifies why retention of voucher specimens is critical. Tentative determinations may be aided by using Stone et al. (1965) for distributional information.

Taxonomy of other families of flies can be approached using these same resources. The Manual of Nearctic Diptera (McAlpine et al. 1981, 1987, 1989) will be the most important single reference. Of special note for Bombyliidae is Hull (1973). The remainder of the taxa will need to be addressed from the primary literature and by consultation with specialists. Many references can be found in Stone et al. (1965) and McAlpine et al. (1981, 1987, 1989).

For the Hymenoptera there is no equivalent of the Manual of Nearctic Diptera. Hymenopterists are trying to produce such a work, but it is impossible until some fundamental taxonomic work is completed, especially in the Chalcidoidea. Hymenoptera of the World: An identification guide to families (Goulet and Huber 1993) will permit determination to the family level. Thus, access to keys to genera requires going to the primary literature. However, identifications can often be facilitated by referring to the Catalog of Hymenoptera in America North of Mexico (Krombein et al. 1979). Distributional and biological information in the Catalog may be of direct value, and taxonomic works up to 1979 are cited. References are also available in Goulet and Huber (1993). Thus, I will not list numerous specific papers.

Biology

Accounts of parasitoid biologies can be found in Askew (1971), Clausen (1940), Waage and Greathead (1986). Some additional general information is available from Balduf (1935, 1939), DeBach (1973) and Huffaker and Messenger (1976). A synopsis is presented in Table 1.

For Diptera information can be found in McAlpine et al. (1981, 1987, 1989) and other taxonomic references. The Natural History of Flies (Oldroyd 1964) is also a useful reference. For Tachinidae, A Host-Parasite Catalog of North American Tachinidae (Diptera) (Arnaud 1978) is the single most important reference. The Diptera catalog (Stone et al. 1965) does not include biological information.

Biological information on individual species of Hymenoptera is available in the catalog (Krombein et al. 1979). The catalog, plus Goulet and Huber (1993) and The Hymenoptera (Gould and Bolton 1988) give overviews of higher level taxa. References included in these volumes give access to the primary literature.

For all parasitoids it must be noted that our biological information is virtually restricted to host-parasite relationships. We know almost nothing about requirements of adult parasitoids beyond basic generalizations, e.g. pollen, nectar, honeydew, hosts (for host-feeding) and free water have been found to be important to specific parasitoids. Another consideration is the possibility of alternate hosts, which may be facultative or obligatory (usually due to phenological asynchrony with the known or dominant host). Ignorance in these areas makes virtually all conclusions regarding conservation and management of parasitoids tentative.

Biogeography

Because of basic taxonomic deficiences comments on the biogeography of most parasitoids are impossible. This situation is exacerbated by our ignorance of the regional fauna.

Thus, nothing can be said about the parasitoids as a whole. Some specific taxa have been examined and a thorough survey of the CRB could allow could permit placing the regional fauna in a biogeographic context.

Table 1. Taxa including Insect Parasitoids in North America

Neuroptera
- Mantispidae
  - Symphrasinae (formerly Platymantispinae)
    - Species parasitize pupae of insects, mostly Hymenoptera, in the soil.

Coleoptera
- Carabidae
  - Lebiinae
    - Some species parasitize larvae or pupae of other insects under bark.
  - Brachininae
    - Some species parasitize pupae of Hydrophilidae in the soil.
- Staphylinidae
  - Aleocharinae
    - Parasitize fly pupae.
- Sandalidae
  - Parasitize Cicadidae nymphs in the soil.
- Bothrideridae
  - Parasitize pupae of insects under park.
- Cucujidae
  - Passandrinae
    - Parasitize pupae of Coleoptera under bark.
- Meloidae
  - Parasitize a variety of hosts, mostly bee larvae and grasshopper eggs.
- Rhipiphoridae
  - Parasitize a variety of aculeate Hymenoptera (Tiphiidae, Scoliidae, Vespidae, Halictidae and Anthophoridae).

Strepsiptera
- Mengeidae
  - Parasitize Cydnidae.
- Stylopidae
  - Parasitize aculeate Hymenoptera (Vespidae, Sphecidae, Colletidae, Halictidae and Andrenidae).
- Elenchidae
  - Parasitize Fulgoroidea.
- Halictophagidae
  - Parasitize Cicadellidae, Cercopidae, Membracidae and Tridactylidae.

Lepidoptera
- Epipyropidae
  - Parasitize Lepidoptera larvae.

Diptera

Chironomidae

Some species parasitize casebearing Trichoptera larvae.

Cecidomyiidae

Some species parasitize Aphididae, Psyllidae and Coccoidea.

Bombyliidae

Most parasitize soil-nesting bees. Some species attack other Hymenoptera, Diptera, Coleoptera and Neuroptera larvae or Acrididae eggs.

Phoridae

Some species are commensals or parasites in nests of termites and ants.

Pipinculidae

Parasitize Homoptera, mostly Cicadellidae and Cercopidae.

Conopidae

Parasitize adult bees (mostly bumble bees) and aculeate wasps.

Pyrgotidae

Parasitize adult Scarabaeidae.

Drosophilidae

A few species are ectoparasitic on Lepidoptera larvae.

Cryptochaetidae

Parasitize Coccoidea.

Sarcophagidae

Some parasitize Acrididae, Coleoptera, Apoidea and aculeate wasps.

Rhinophoridae

Parasitize sowbugs (Isopoda).

Tachinidae

All are aprasites of other insects or other arthropods. Most attack larvae of Lepidoptera (48 families), Symphyta (5 families) and Coleoptera (16 families). Others parasitize Dermaptera, Diptera, Hemiptera, Homoptera, Orthoptera and centipedes (Chilopoda).

Hymenoptera

Symphyta

Orussidae

Parasitize wood-boring Coleoptera (mostly Buprestidae) larvae, usually in

old logs without bark. They are rarely collected.

Apocrita

Stephanoidea

Stephanidae (6 species in U.S.)

Parasitize wood-boring Coleoptera and Siricidae larvae in fresh logs with bark. They are rarely collected.

Trigonaloidea

Trigonalidae (4 species in U.S.)

Hyperparasites in Lepidoptera or Symphyta larvae, via Ichneumonidae or Tachinidae, or parasites of Vespidae larvae via Lepidoptera larva. They are rarely collected.

Ichneumonoidea

Ichneumonidae (~8000 species in U.S.)

Parasitize many Holometabola larvae (excluding Mecoptera, Megaloptera and Siphonaptera) and spider egg masses, or are hyperparasites in similar indirect hosts.

Braconidae (~2000 species in U.S.)

Parasitize immatures and occasionally adults of Holometabola and Hemimetabola. Includes the Aphidiinae (=Aphidiidae) that parasitize aphids.

Proctotrupoidea

Heloridae (1 species in U.S.)

Parasitize larvae of Chrysopidae, mostly *Chrysopa nigricornis* Burmeister that occurs on deciduous trees. They are rarely collected.

Roproniidae (7 species in U.S.)

Parasitize larvae of Symphyta. They are rarely collected.

Vanhorniidae (1 species in U.S.)

Parasitize larvae of Eucnemidae. They are rarely collected.

Scelionidae

Telenominae (~70 species in U.S.)

Parasitize eggs of Hemiptera, plus some Leipidoptera and a few Tabanidae.

Teleasinae (~110 species in U.S.)

Most parasitize Coleoptera eggs.

Scelioninae (~100 species in U.S.)

Parasitize eggs of Orthoptera, Hemiptera and spiders.

Platygastridae

Inostemmatinae (20 species in U.S.)

Parasitize mostly Cecidomyiidae in galls, but some attack Lepidoptera and Coccoidea.

Platygastrinae (168 species in U.S.)
Parasitize gallicolous larvae, mostly Cecidomyiidae, plus some Cynipidae and Tenthredinidae.
Sceliotrachelinae (6 species in U.S.)
Parasitize Coleoptera eggs and nymphal Aleyrodidae.

Proctotrupidae (~55 species in U.S.)
Most parasitize Coleoptera larvae (Carabidae, Staphylinidae, Nitidulidae, Erotylidae, Elateridae, Coccinellidae and Curculionidae), but there are reports of Mycetophilidae and one centipede being hosts.

Diapriidae
Ambositrinae (1 species in U.S.)
Hosts unknown.
Ismarinae (2 species in U.S.)
Probably secondary parasites of Dryinidae.
Belytinae (~170 species in U.S.)
Most parasitize Mycetophilidae.
Diapriinae (~135 species in U.S.)
Parasitize Diptera larvae (Ceratopogonidae, Syrphidae, Stratiomyidae, Lonchaeidae, Tephritidae, Anthomyiidae, Tachinidae, Ephydridae, Calliphoridae, Sarcophagidae, Drosophilidae, Tabanidae, Agromyzidae and Sciomyzidae).

Ceraphronoidea
Ceraphronidae (~50 species in U.S.)
Parasitize larvae of Diptera (Cecidomyiidae, Drosophilidae, Phoridae, Sciaridae and Syrphidae), Homoptera (Aleyrodidae, as primary parasities, Coccoidea and Aphididae, as secondary parasites), Neuroptera (Chrysopidae and Hemerobiidae) and Hymenoptera (Braconidae, Ichneumonidae, Bethylidae and Dryinidae).

Megaspilidae
Megaspilinae (~60 species in U.S.)
Parasitize immatures of Diptera (Cecidomyiidae, Chamaemyiidae, Muscidae and Syrphidae) Homoptera (Aphididae, Chermidae, Pseudococcidae, Psyllidae, apparently as secondary parasites), Coleoptera, Neuroptera (Coniopterygidae) and Mecoptera (Boreidae).
Lagynodinae (3 species in U.S.)
Have been found in ant colonies, may parasitize ants or myrmecophiles.

Chalcidoidea
Mymaridae (~120 species in U.S.)
Parasitize eggs of Homoptera (Cicadellidae, Cercopidae, Membracidae, Aleyrodidae and Coccoidea), Coleoptera (Chrysomelidae, Curculionidae and Dytiscidae), Hemiptera (Gerridae and Lygaeidae), Diptera (Tephritidae),

Odonata (Lestidae), Lepidoptera, Neuroptera and Psocoptera.

Trichogrammatidae (~40 species in U.S.)
Parasitize eggs of Lepidoptera, Coleoptera, Megaloptera, Neuroptera, Hymenoptera, Diptera, Hemiptera, Homoptera and Thysanoptera.

Eulophidae (many species in U.S.)
Eulophinae
Most parasitize leaf-mining Lepidoptera or Diptera, but some attack Coleoptera and Hymenoptera (mostly Symphyta) larvae.
Entodontinae
Parasitize most orders of insects, attacking eggs, nymphs, larvae and pupae, they also attack spiders. One is reported to prey on mites and some appear to be phytophagous.

Elasmidae (16 species in U.S.)
Parasitize microlepidoptera larvae as primary and/or secondary parasites via Braconidae or Ichneumonidae.

Signiphoridae (22 species in U.S.)
Parasitize Homoptera (Aleyrodidae, Coccidae and Diaspididae) and Diptera. Some may be secondary parasites through Aphelinidae or Encyrtidae.

Aphelinidae (~130 species in U.S.)
Most are parasites of Homoptera (Aphididae, Aleyrodidae and Coccoidea). Some are secondary parasites. Some genera area adelphoparasitic (males parasitize females).

Encyrtidae (many species in U.S.)
Most are primary parasites of Homoptera (Aphididae, Coccoidea and Psyllidae), Lepidoptera (many families), Coleoptera (Chrysomelidae and Coccinellidae), Diptera (Cecidomyiidae, Syrphidae and Muscoidea), Neuroptera (Chrysopidae and Coniopterygidae), Hemiptera (many families, usually attacking eggs), and ticks. Some are secondary parasites, usually attacking Chalcidoidea or Dryinidae in Homoptera. Some are polyembryonic.

Eupelmidae
Eupelminae (~75 species in U.S.)
They include primary and secondary parasites of eggs, nymphs and larvae of Hymenoptera, Diptera, Coleoptera, Lepidoptera, Homoptera, Hemiptera and spiders.
Calosotinae (13 species in U.S.)
Parasitize endophytophagous hosts: Cecidomyiidae and Eurytomidae in grasses and Buprestidae and Cerambycidae in twigs and branches.

Pteromalidae (many species in U.S.)

Brachyocelidiphaginae (1 species in U.S.)

Galls *Vaccinium* spp.

Colotrechninae (1 species in U.S.)

Reared from Asteraceae flowerheads, may be phytophagous or a parasitoid.

Macromesinae (1 species in U.S.)

Parasitizes Scolytidae larvae in the Pacific Northwest.

Spalangiinae (9 species in U.S.)

Parasitize Diptera pupae (Agromyzidae, Drosophilidae, Muscidae, Tephritidae and Sarcophagidae).

Cerocephalinae (8 species in U.S.)

Parasitize Coleoptera larvae, usually wood-boring species.

Diparinae (4 species in U.S.)

No biological information.

Eunotinae (6 species in U.S.)

They are predators of Coccoidea eggs.

Asaphinae (6 species in U.S.)

Most are secondary parasites of Aphidiinae and Aphelinidae in aphids. Some parasitize Neuroptera larvae.

Panstenoninae (2 species in U.S.)

No biological information available.

Miscogasterinae (~60 species in the U.S.)

Most parasitize Diptera (Agromyzidae, Cecidomyiidae, Tephritidae and Calliphoridae). Some attack Coleoptera (Chrysomelidae, eggs, and Nitidulidae).

Pteromalinae (many species in U.S.)

Biologically diverse, developing as primary parasites on most orders or as secondary parasites on a variety of Hymenoptera..

Eutrichiosomatinae (1 species in U.S.)

Parasitizes Curculionidae larvae.

Cleonyminae

Most parasitize Lepidoptera and Coleoptera, including Scolytidae. Some attack Diptera and Hymenoptera. A few are egg predators on Coccoidea.

Ormyridae (12 species in U.S.)

Parasitize gallicolous insects, mostly Cynipidae.

Perilampidae (~30 species in U.S.)

Most are hyperparasities of Tachinidae, Braconidae and Ichneumonidae. Some are primary parasites of Lepidoptera, Coleoptera, Hymenoptera and Neuroptera.

Eucharitidae (~28 species in the U.S.)

All parasitize ants.

Torymidae

Toryminae (~110 species in U.S.)

Most species parasitize gall-forming Hymenoptera (mostly Cynipidae), Diptera (mostly Cecidomyiidae and Tephritidae) and Psyllidae. A few species are phytophagous.

Erimerinae (4 species in U.S.)

Parasitize grass stem boring Hymenoptera and Diptera.

Monodontomerinae (32 species in U.S.)

Parasitize endophytophagous, including gallicolous, Coleoptera, Diptera, Hymenoptera and Lepidoptera.

Podagrioninae (5 species in U.S.)

Parasitize mantis egg masses.

Eurytomidae

Rileyinae (10 species in U.S.)

Parasitize Gryllidae eggs, Cecidomyiidae larvae in galls and Cicadidae eggs.

Harmolitinae (~70 species in U.S.)

Form galls in grass stems.

Eudecatominae (~45 species in U.S.)

Parasitize endophytophagous and gallicolous larvae, mostly Cynipidae and Cecidomyiidae.

Aximinae (6 species in U.S.)

Most parasitize Apoidea and Curculionidae. Some are phytophagous.

Prodecatominae (3 species in U.S.)

Some develop in angiosperm seeds, others occur in Cynipidae galls as inquilines or parasites.

Eurytominae (~120 species in U.S.)

Most parasitize endophytophagous or gallicolous Diptera, Hymenoptera, Homoptera, Leipdoptera and Coleoptera. Some are hyperparasites. Some are probably inquilines in galls and some are phytophagous.

Chalcididae

Haltichellinae (~10 species in U.S.)

Most parasitize Lepidoptera larvae or pupae.

Dirhininae (3 species in U.S.)

Parasitize Lepidoptera and Tephritidae.

Chalcidinae (~55 species in U.S.)

Some parasitize Lepidoptera and Diptera. Others are hyperparasites of Braconidae, Ichneumonidae and Tachinidae in Lepidoptera.

Brachymerinae (~40 species in U.S.)

Most parasitize Lepidoptera larvae or develop as secondary parasites of Braconidae, Ichneumonidae or Tachinidae in these hosts. Some species may parasitize Buprestidae and Diptera.

Leucospididae (5 species in U.S.

Parasitize Apoidea (especially Megachilidae) and aculeate wasps (especially

Sphecidae) that nest in twigs or stems.

Cynipoidea

IbalIiidae (7 species in U.S.)

They are solitary endoparasites of Siricidae larvae in freshly fallen logs. They are rarely collected.

Liopteridae (3 species in U.S.)

Biology poorly known, some appear to parasitize Buprestidae larvae. They are rarely collected.

Figitidae

Aspicerinae (7 species in the U.S.)

Parasitize Syrphidae larvae.

Anacharitinae (~25 species in U.S.)

Parasitize Chrysopidae and Hemerobiidae larvae.

Figitinae (~30 species in U.S.)

Parasitize Diptera, especially Muscoidea, larvae.

Eucoilidae (~80 species in U.S.)

Parasitize Diptera larvae.

Alloxystidae (~30 species in U.S.)

Hyperparasites of Aphidiinae and Aphelinidae in Aphididae and rarely Psyllidae.

Cynipidae

Cynipinae (~475 species in U.S.)

They are gall formers: 80% on Oaks, 12% on Rosaceae, with the remainder attacking a variety of plant genera and families.

Synerginae (~90 species in U.S.)

Most are inquilines in galls of Cynipinae. Some occur with other gall forming insects, usually Cecidomyiidae.

Evanioidea

Evaniidae (11 species in U.S.)

Parasitize cockroach oothecae.

Aulacidae (~30 species in U.S.)

Parasitize woodboring Coleoptera and Hymenoptera (mostly Siricidae) larvae in recently fallen or dead trees that retain bark.

Gasteruptiidae (~15 species in U.S.)

Parasitize larvae of Apoidea (mostly Colletidae, Andrenidae and Megachilidae) and aculeate wasps (mostly Sphecidae) that nest in wood.

Literature Cited

Askew, R.R. 1971. Parasitic Insects. American Elsevier, New York, 316 p.

Balduf, W.V. 1935. Bionomics of Entomophagous Coleoptera. John Swift Co. St. Louis. 220 p.

Balduf, W.V. 1939. Bionomics of Entomophagous Insects, Pt. 2. John Swift Co., St. Louis. 384 p.

Clausen, C.P. 1940. Entomophagous Insects. McGraw-Hill, New York, 688 p.

Cole, F.R. 1969. The Flies of Western North America. U. of Calif. Press, Berkeley. 693 p.

Curran, C.H. 1965. The Families and Genera of North American Diptera. Henry Tripp, Woodhaven, NY. 515 p.

DeBach, P. 1973. Biological Control of Insect Pests and Weeds. Chapman and Hall, London, 806 p.

Gould, I. and B. Bolton. 1988. The Hymenoptera. Oxford Univ. Press. New York. 332 p.

Goulet, H. and J.T. Huber. 1993. Hymenoptera of the world: An identification guide to families. Agriculture Canada, Ottawa. 668 p.

Huffaker, C.B. and P.S. Messenger. 1976. Theory and Practice of Biological Control. Academic Press, New York, 788 p.

Hull, F.M. 1973. Bee Flies of the World. Smithsonian Institution Press, Washington D.C. 687 p.

Krombein, K.V. et al. 1979. Catalog of Hymenoptera in America North of Mexico, Vols. 1, 2, & 3. Smithsonian Institution Press, Washington D.C. 2735 p.

McAlpine, J.F. et al. 1981, 1987, 1989. Manual of Nearctic Diptera, Vol. 1, 2 & 3. Agriculture Canada, Hull Quebec. 1581 p.

Oldroyd, H. 1964. The Natural History of Flies. Weidenfeld and Nicolson, London. 324 p.

Stone, A. et al. 1965. A Catalogue of the Diptera of America North of Mexico. Agriculture Handbook No. 276. USDA/ARS, Gov't. Printing Office, Washington, D.C. 1696 p.

Waage, J. and D. Greathead. 1986. Insect Parasitoids. Academic Press. New York, 390 p.

Wood, D.M. 1987. Tachinidae, pp. 1193-1269 in Manual of Nearctic Diptera, Vol. 2, J.F. McAlpine ed., Agriculture Canada, Hull, Quebec.

Parasitic Hymenoptera as Means of Monitoring Habitat Condition in the CRB

James B. Johnson

Parasitoids are influenced directly and indirectly, via their host(s), by habitat condition and change. Thus, they have the potential to be used as indicators of these factors. Indeed, they have some special advantages in this regard. However, it must be acknowledged that our meager taxonomic and biological understanding of this group still limits their utility.

In general, parasitoids are more host specific than are predators (Hagen et al. 1976). Thus, they are more likely to be affected by changes in the habitat because they are less apt to simply change food sources. Instead, their population densities will tend to change (including to the point of local extinction) due to environmental alterations.

Parasitoids are a large group. They include approximately 10,500 species in the U.S. (Krombein et al. 1979; McAlpine et al. 1981, 1987, 1989). This is important in terms of having numerous species in each habitat type. With many species in each type of habitat it makes the group more sensitive to changes and allows correlations of species that also enhance their sensitivity (see Mike Ivie's report for references).

Within the parasitoids there are two large sub-groups, the Diptera and the Hymenoptera (see Table 1 in my first report). The parasitic Hymenoptera are more speciose with approximately 9500 species in North America (Krombein et al. 1979) as opposed to 1000 species of parasitic Diptera (McAlpine et al. 1981, 1987, 1989). Thus, though there is no estimate of the number of species in the CRB, the Hymenoptera are more likely to offer a sufficient number of taxa within each habitat type to be sampled.

There are several other factors that make the hymenopteran parasitoids especially useful as indicators of environmental change. Adults of most Diptera and Hymenoptera are winged. This allows sampling with efficient, passive systems that yield relatively clean samples, e.g. flight intercept traps. Thus, we can obtain unbiased samples which is critical. Additionally, clean samples, relatively free of debris, are quicker and easier to sort, saving time and money. However, sample preservation in kinds of traps is best done in liquid. In this situation the Hymenoptera are more likely to be preserved well enough to permit identification. Still, even a week in the liquid will make it impossible to identify some Hymenoptera below the generic level, which will limit their utility.

Two additional factors make the hymenopteran parasitoids particularly useful. The first is the generally greater host specificity of individual species. Hymenoptera that are endoparasitic overcome their hosts' immune system by relatively subtle means, specialized, co-evolved venoms or mutualistic polydna viruses (refs. in Waage and Greathead 1986). Tachinidae larvae, on the other hand, anchor their spiracles in the host's exoskeleton to ensure access to the atmosphere for oxygen and simply keep rasping with their mouthhooks to avoid being completely encapsulated (refs. in Waage and Greathead 1988).

Hymenoptera also have a broader host range than the Diptera. Hymenoptera are known to parasitize hosts in 21 orders (Krombein et al. 1979). Diptera are known to attack 11 orders of insects as hosts (McAlpine et al. 1981, 1987, 1989). See Table 1 in my first report for a more detailed accounting.

Thus, by sampling members of a single order of insects, thereby minimizing the diversity of taxonomic expertise required, it would be possible to indirectly assess the occurrence of environmental changes on a much wider array of taxa and functional groups living in niches from

the soil to the tree canopies. To more fully understand the nature and impact of environmental changes, it would be desirable and often necessary to conduct further taxonomic studies of hymenopteran parasitoids and to study their biological interactions in more detail. This limitation will not preclude gaining useful information at this time. Additionally, there is a Hymenoptera Training Course offered almost every year by systematists from the USDA, the Smithsonian Institution and various universities that would facilitate the first phase of training parataxonomists to handle these taxa. Further training would require working with experts in specific taxa.

Hagen, K. S., S. Bombasch and J. A. McMurtry. 1976. The Biology and Impact of Predators, p. 93-142, In: Huffaker, C. B. and P. S. Messenger (eds), Theory and Practice of Biological Control, Academic Press, NY, 788 pp.

Krombein, K. V. et al. 1979. Catalog of the Hymenoptera in America North of Mexico, Vols. 1, 2 and 3. Smithsonian Institution Press, Washington D.C. 2735 p.

McAlpine, J. F. et al. 1981, 1987, 1989. Manual of Nearctic Diptera, Vols. 1, 2 and 3. Agriculture Canada, Hull, Quebec. 1581 p.

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Columbia River Basin - Panel Species Information

Page ___ of ___

Date 20 Jan 95 Panelist Name James B. Johnson (optional)

Species or Species Group: Parasitoids

Province and/or Section:

"I did not complete this form because..."

Key Environmental Correlates

1. _____

Categorical ☐ Continuous ☐

Suitable Categories:

1 _____
2 _____
3 _____
4 _____
5 _____
6 _____

Unit of Measure: _____

Minimum: _____

Maximum: _____

Applies seasonally? Yes ☐ No ☐

Which seasons? _____

2. _____

Categorical ☐ Continuous ☐

Suitable Categories:

1 _____
2 _____
3 _____
4 _____
5 _____
6 _____

Unit of Measure: _____

Minimum: _____

Maximum: _____

Applies seasonally? Yes ☐ No ☐

Which seasons? _____

3. _____

Categorical ☐ Continuous ☐

Suitable Categories:

1 _____
2 _____
3 _____
4 _____
5 _____
6 _____

Unit of Measure: _____

Minimum: _____

Maximum: _____

Applies seasonally? Yes ☐ No ☐

Which seasons? _____

4. _____

Categorical ☐ Continuous ☐

Suitable Categories:

1 _____
2 _____
3 _____
4 _____
5 _____
6 _____

Unit of Measure: _____

Minimum: _____

Maximum: _____

Applies seasonally? Yes ☐ No ☐

Which seasons? _____

Key Ecological Functions

1. Parasitoids are biological mortality factors affecting other animals, almost always insects

2.

3.

Key Assumptions:

Key Unknowns and Monitoring or Research Needs:

Taxonomic study of most taxa
Host-parasite relationship for many species, including alternate hosts
Adult parasitoid requirements, food, water, shelter
Assess impact of environmental changes on hosts and parasitoids

Dispersal:

Dispersal mode: winged adult (most) some active L1

Requirements for dispersal:

Degree of confidence in knowledge of species:

- High
- Med.
- Low

Trend

- Increasing
- Stable
- Decreasing
- Unknown

Comments: This group is very poorly known taxonomically and biologically. While maintaining the host is critical it may not be enough to maintain the parasitoid as non-host requirements are usually unknown. Management is not truly possible at this time.